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(71) Applicant *(for all designated States except US)*: **SUNDERLAND BLACK** [GB/GB]; 27 Upper Lane, Netherton, Wakefield, West Yorkshire W24 4NG (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **COLLIER, Nicholas** [GB/GB]; Scientific Generics Limited, Harston Mill, Harston, Cambridge CB2 5GG (GB). **SUNDERLAND, Joseph, William** [GB/GB]; 9 Aysgarth Drive, Lupset, Wakefield WF2 8UG (GB).

(74) Agents: **ROBERTS, Gwilym, Vaughan** et al.; Kilburn & Strode, 20 Red Lion Street, London WC1R 4PJ (GB).

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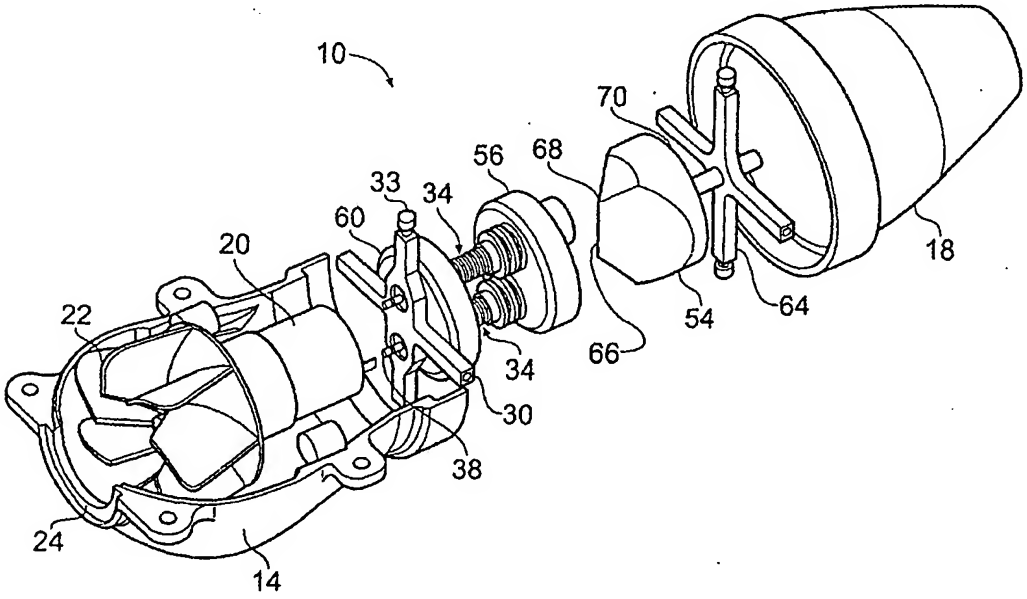

(57) Abstract: A cordless hairdryer (10) comprises a gas burner (34) and a fan (22). A first baffle (58) shrouds the burner against airflow and a second baffle (54) deflects combusted gas exiting the burner (34) so as to mix with airflow.

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Hairdryer

The invention relates to a cordless hairdryer of the type comprising a rechargeable batter to power a motor that drives a fan, and a gas canister to supply gas to a catalyst for flameless combustion and which provides heat to the air driven by the fan.

The concept of such a hairdryer is well known, (see for example, US-A-5009592, US-A-4635382, US-A-4800654, US-A-4903416, DE-A-3103843) but no commercial product has yet been launched on the market. The reasons for this are complex and are connected with, among other things, the inefficiency of batteries and the inability to convert the potential energy in the gas to heat in the air in an efficient way.

One of the problems addressed by the invention is to ensure that electronic or electrical failure does not compromise product safety, especially in view of the proximity of the gas reservoir and electrical components.

It is further an object of the present invention to provide a hairdryer that overcomes the difficulties experienced, or at least mitigates their effects.

Aspects of the invention are set out in the claims.

With this arrangement of heating the air by mixing the airflow with combusted gas after its exit from the burner, and by shrouding the burner so that there is no danger of the burner being cooled by the airflow, the risk that flameless combustion might be terminated is eliminated.

The second baffle preferably comprises a ceramic block that leaves an annular space in the air passage through which the combusted gas and air flow. Preferably, the second baffle is truncated at its rear end in the direction of air and combusted gas flow to create turbulence in the flow to ensure complete mixing of the air and combusted gas.

According to the invention there is further provided a hairdryer, preferably a cordless hairdryer, comprising a burner, a fuel reservoir storing fuel and an electromechanical control for controlling fuel supply from the reservoir. Preferably the control includes a reservoir valve and an electronic valve control circuit. Preferably the reservoir valve is set to close on failure of the control circuit, for example comprising a biased closed solenoid valve. Preferably the control circuit includes a valve control element that is electrically isolated from the control circuit; for example it can be opto-isolated. The control circuit may include one or more condition sensors, for example an undertemperature or overtemperature sensor.

According to another aspect of the invention there is provided a hairdryer, preferably a cordless hairdryer, comprising a burner, a flow passage, and at least one baffle diverting flow in the passage, in which a condition sensor is provided in conjunction with the baffle. Preferably the condition sensor is an undertemperature or overtemperature sensor. Preferably the baffle shrouds the burner, preventing airflow from cooling the burner and/or deflects combusted gas exiting the burner so that it mixes with air flowing around the burner.

The invention is further described hereinafter, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is an exploded perspective view of the main components of a hairdryer according to the present invention;

Fig. 2 is a section through the hairdryer;

Fig. 3 shows a control and safety circuit diagram for the hairdryer;

Fig. 4 shows user controls and indicators for the hairdyer;

Fig. 5 shows one possible component format for the hairdryer;

Fig. 6 shows an alternative possible format for the components of the hairdryer;

Fig. 7a is an exploded diagram showing an alternative format for the hairdryer;

Fig. 7b is a schematic side sectional view showing the format of Fig. 7a;

Fig. 8a is an exploded diagram showing a further alternative format for the hairdryer;

Fig. 8b is a schematic side sectional view showing the format of Fig. 8a;

Fig. 9a is an exploded diagram showing a further alternative format for the hairdryer;

Fig. 9b is a schematic side sectional view showing the format of Fig. 9a;

Fig. 10a is an exploded diagram showing a further alternative format for the hairdryer;

Fig. 10b is a schematic side sectional view showing the format of Fig. 10a

Fig. 11a is an exploded diagram showing a further alternative format for the hairdryer;

Fig. 11b is a schematic side sectional view showing the format of Fig. 11a;

Fig. 12a is an exploded diagram showing a further alternative format for the hairdryer; and

Fig. 12b is a schematic side sectional view showing the format of Fig. 12b.

Referring to Figure 1 and 2, a hairdryer 10 comprises a housing 12 which at one end consists of two clamshell halves 14a,b, a middle, tubular section 16, and an end nozzle 18. In the clamshell end 14 is mounted a motor 20 driving a fan 22. The fan 22 draws air axially through an end aperture 24 (which may be

guarded by a grill (not shown) to prevent finger access to the fan 22). The fan 22 expels air radially, but the clamshells 14a, b are shaped so that air exiting the fan 22 is deflected longitudinally into the tubular portion 16 of the housing 12. The arrangement therefore provides a tubular-like flow of air through the air passage 26 defined by the housing 12. Indeed, the motor 20 defines an angular start 26a of the air passage 26.

A cross element 30 is mounted at the entrance to the tubular part 16 of the housing 12. Screws 33 secure the cross in place. Two threaded bores 32 are provided in the cross 30, one above the other, and into each of these is screwed a burner 34.

Each burner 34 comprises a brass collar 36 screwed into the bore 32 and provided with a gas terminal 38. A gas pipe (not shown) from a gas supply (not shown) via a trigger or other supply control mechanism (not shown) is connectable to the terminal 38. The terminal 38 is provided with a narrow bore that opens into the interior of the collar 36, jetting gas therein. A neck 40 of pressed/sintered metal is screwed into the collar 36. Inside the neck 40 is disposed a plug 42 of porous metal that serves to regulate gas flow through the burner 34. On exit from the plug 42 gas flows along a bore 44 of the neck 40 where it mixes with air drawn in through a cross bore/port 46.

Air is drawn into the port 46 by virtue of the low pressure in the bore 44 caused by the high velocity gas flow therein and controlled by the plug 42. A stoichiometric volume of gas and air therefore flows along the neck 40 and enters sleeve 50. Finally, in a broad section 52 of the sleeve 50 is disposed a coiled catalytic wire, coated with platinum (not shown), where the combustible gas mix combusts in the absence of a flame.

Finally, the combusted gases exit the burners 34 and impinge on a ceramic block baffle 54 to be deflected radially outwardly so as to mix with the tubular air flow caused by the fan 22.

A second baffle 56 is provided around the sleeves 50 to further define the tubular flow by defining annular space 26c of the air passage 26. The second baffle 56 prevents the air flow from directly contacting the burners 34 in the region of the cups 52 where the catalyst is disposed. This ensures that the catalyst remains at the requisite temperature to guarantee complete combustion of the combustible gas. As shown, the baffle 56 is mounted on one of several fins 58 of each burner 34, especially that one closest to the cup 52. However, it could equally well be mounted on its own spider from the internal surface of housing part 16.

The fins 58, which also extend to the neck 40, serve to shed heat developed in the burner cup 52 and conducted along the material of the burner 34. This heat is shed by both convection with the surrounding air flow, as well as by radiation. Indeed, the latter is more significant given a third baffle 60 which is, like the baffle 56, a disc having a cupped edge. This also defines the tubular air passage by annular space 26b. The baffle 60 is held against the cross 50 by the burners 34 passing through apertures (not shown) in the baffle 60. The baffle 60 guards the ports 46, and prevents air flow, driven by the fan 22, from drawing gas out of the ports 46. Instead, stagnant air behind the baffle 60 is at a relatively high pressure compared with the gas flowing through the bore 44 of the neck 40 of the burners 34.

Returning to the second baffle 54, it is mounted on a rod 62 and a further cross 64 inside the tubular housing part 16. On the end of the housing part 16, a nozzle 18 is disposed, which maybe shaped to further enhance mixing.

As noted already, there are two burners 34, each expelling hot exhaust gases

against the baffle 54. The baffle 54 has a ridge 66 aligned with the line joining the longitudinal axes of each burner. Most of the outflow from each burner is shed to one side or the other of the ridge 66. However, a hip 68 is formed on the baffle 54 at either end of the ridge. Gases exiting a sector of each burner remote from the other burner are thus deflected at right angles to the ridge-deflected gases. This spreads the infiltration of the hot gasses into the air flow, so that more effective mixing occurs with less likelihood of hot spots occurring.

The baffle 54 is terminated by a blunt end 70, so that airflow around it is turbulent, further enhancing gas mixing and temperature stabilisation.

As discussed above, in overview the hairdryer includes a gas burner and gas reservoir and a fan. In addition, as discussed in more detail below, a control circuit and a battery for powering the fan are provided. A first baffle shrouds the burner, preventing airflow from cooling the burner. A second baffle deflects combusted gas exiting the burner so that it mixes with air flowing around the burner.

Figures 5 to 12 show various product configurations in schematic form for a hairdryer according to the invention, with the housing and control components not shown, for clarity. Each figure shows a cordless drier designated generally 300 including a fan 302, a burner 304, end nozzle 306, battery pack 308 and gas canister 310. The fan 302, burner 304 and nozzle 306 define a generally linear axis 312 with the burner 304 intermediate the fan 302 and nozzle 306, but various configurations of the remaining components are contemplated. In each case the design avoids obstruction of the airflow through the fan, to keep the power required to drive the fan to a minimum.

Referring to Fig. 5 the battery pack with larger capacity cells is slung below and parallel with the axis 312, in a 2x2 configuration forwardly of the fan 302. The gas canister 310 projects perpendicularly below the axis 312, between the fan 302 and battery pack 308, and can be received in a handle significantly spaced from the burners, enhancing safety. In Fig. 6 the positions of the battery pack 308 with larger capacity cells and gas canister 310 are reversed away from the burners, increasing their capacity. In Fig. 7a and 7b the arrangement is shown with the gas canister 310 positioned along the axis 312 but rearwardly of the fan 302, and having a more squat configuration.

Referring to Fig. 8a and 8b the arrangement is similar to that shown in Fig. 6 but with the gas canister 310 placed above rather than below the axis 312.

The arrangement of Fig. 9a and 9b is similar to that of Fig. 6 but with the profile of the gas canister 310 varied slightly so as to taper from the base up.

Referring to Fig. 10a and 10b the configuration is similar to that of Fig 7 except that the orientation of the fan is changed. In particular is lies below and perpendicular to the axis 312, impelling air towards the axis. As a result a suitable deflector would be required to divert the air towards the burner.

Fig. 11a and 11b is also similar to Fig. 7 except that the gas canister 310 is more elongate, as is the fan 302 housing. Also the battery pack 308 is provided in a 4x1 configuration.

Referring lastly to Fig. 12a and 12b all of the components are aligned with the axis 312. The gas canister extends along the axis rearwardly of the fan 302 and the batteries are distributed around its circumference. In the embodiment

shown the batteries are provided at 90° intervals in grooves provided in the outer wall of the canister.

Turning in more detail to aspects of the invention, control and safety circuits control the motor speed, burner level, burner ignition and provide safety shutdown in the case of various failure modes. As the controls and burner are likely to be physically remote, purely mechanical controls and safety features are less desirable. As an electrical power source is available (for the motor), at least part of the gas control system is preferably electrically powered and/or sensed. This provides the most versatile method of control, is the least involved and risky from a development point of view, and allows controls almost identical to a standard corded hairdryer.

Referring to the control and safety circuit block diagram shown as 399 in Fig. 3, the rechargeable battery pack 400 supplies all electrical power to the hairdryer. The positive supply from the battery is switched through a mechanical on/off switch 402. In the off position no power is available to energise the normally closed (spring return) solenoid operated gas shut-off valve 404, comprising a reservoir valve.

When the switch 402 is in the on position the live connection from the battery connects to a vane type airflow switch 406. This consists of a plastic moulded vane and microswitch. When the fan is on and the airflow is above a minimum value the switch 406 closes and the battery supply 400 is connected to the over-temperature thermal switch 408. In an alternative embodiment it is possible to omit the flow switch 406 and rely purely on the over-temperature switch 408 to detect reduced or absent airflow.

The over-temperature thermal switch 408 of any appropriate type, is placed in close proximity to the burner to detect excessive heating for any reason (excessive burner level, restricted airflow, or failure of the fan/motor). If this switch 408 opens due to excessive temperature, power will be disconnected from the solenold valve 404 shutting off the gas supply 414. The hystereses of this switch 408 should be such that it will not close again until temperature is in the range where the under-temperature switch 416 has opened – preventing the possibility of the gas valve 404 being re-opened as the unit cools down.

The next components in the safety circuit 399 are the under-temperature thermal switch 416 and an override switch 418 connected in parallel. Except when the override switch 418 is held in the ignite position by the user, the under-temperature thermal switch 416 (of any appropriate type) will be open whenever the burner temperature is below a pre-determined value (indicating the burner 410 has not been or is not lit). This removes the supply to the gas control valve 404, switching off the gas supply, if the gas burner 410 is not lit.

Both the over-temperature and under-temperature switches comprise condition sensors which are provided on the baffle 56 shown in Fig. 1.

In order to initially light the burner 410 the override switch 418 is moved to the ignite position which momentarily bypasses the under-temperature switch 416 to provide power to open the gas valve 404. The override switch 418 also provides power to the burner ignition circuit 420 to ignite the gas. As the power supply to an electronic igniter circuit be hardwired through the safety circuit, it is not possible for the igniter circuit to operate unless the switch 418 is in the ignite position.

Once the gas ignites, after a few seconds the under-temperature switch will close and the power supply 400 will remain connected to the solenoid valve 404 after the override switch is released. An opto-isolatec monitoring circuit 422 determines whether the under-temperature switch 416 has closed in order to illuminate an LED indicating that the burner has lit. This monitoring circuit 422 has no effect on the safety circuit and is provided purely as an indicator 424 to the user that the gas is lit and they can release the ignite/override switch 418. Failure of this monitoring circuit 422, whilst it may erroneously indicate whether or not the burner is lit, has no effect on the safety shutdown functions of the gas supply.

In the case where the gas shut-off valve 404 also provides regulation of heat level using for example pulse width modulation of the on/off period of the valve, an opto-isolated signal via isolator 426 for the electronics switches the power on/off to the solenoid valve via isolator 426. Failure of the electronics can never switch on the control valve when the other hardwired safety components indicate a failure condition.

In the case where gas regulation is accomplished using a manual regulator valve 428, the opto isolated control circuit is omitted and the gas solenoid valve 404 is connected directly to the terminals of the under-temperature and override switches 416, 418.

Motor control is not critical to the safety of the hairdryer, and therefore can be controlled electronically, as failure leading to overheating is detected by the hardwired over-temperature switch (and airflow switch if necessary). However safety critical components such as the solenoid valve 404 are hardwired using electromechanical components. Furthermore the HT supply 430 to the igniter 420, and the connection to the solenoid valve are electrically opto-isolated via

respective isolations of any appropriate type 432, 426 in the electronic control circuit 434.

According to this arrangement, the safety critical circuits cannot be compromised by failure of the electronics. The use of optical isolation components to prevent any monitoring or control circuits of the electronics providing power or incorrectly enabling part of the safety circuit ensure this. Failure of the electronic control circuits may prevent operation of the hairdryer, but always in a fail-safe manner.

The safety circuit shuts off the gas supply in the event of failure to ignite the gas burner (or subsequent extinguishing of the burner, either controlled or due to a failure), an over-temperature condition (due to failure of the fan/motor, blockage of airflow etc.) or airflow less than a minimum level.

As regards motor control and electronic gas regulation, there are two embodiments presented regarding the gas regulation (to provide different heat settings). One uses a manual regulator valve 428 to provide variable heat control and the other modulates the on/off period of the gas shutoff valve to control the average gas flow.

The advantage of the electronic control of the solenoid valve is the reduction of mechanical parts (albeit at the increase of electronic control) and more freedom in the mounting position and type of controls.

The electronic control circuit (ECC) 434 which is preferably a printed circuit board provides, in addition to the possible PWM control of the solenoid valve; PWM speed control of the fan motor 42, igniter circuit 430 if desired (see section 3.11), battery monitoring circuit and low battery display LED 436,

burner lit monitoring and display LED 424, mounting platform for on/off/ignition switch, mounting platform for burner and motor control switches 438, 440, and mounting platform for gas solenoid valve 404 and a "junction box" for electrical cabling.

A possible arrangement 499 of the control switches and indicators for a hairdryer according to the invention is shown in Fig. 4.

A single on/off slide switch 500 controls all power from the battery pack to the hairdryer. When this switch is in the "off" position 502, all power is removed from the electronics, fan motor and solenoid gas shut-off valve ensuring that the gas source is closed. The on/off slide switch 500 is recessed and must be depressed before it is possible to move it from the off position. This is to minimise the possibility of accidental operation.

Moving the switch to the "on" position 504 provides power to the electronics and motor control circuits. The fan will run at the speed selected by the "fan speed" control switch 512. This can be a 2 position switch giving two fan speeds, or a number of speed settings. The gas is still turned off at this point.

The on/off slide switch 500 has a third momentary spring loaded position 506. This is the "ignition" position where the user must hold the switch to ignite the gas. Moving the switch to this position opens the gas valve and turns on the HT spark igniter 430 (Fig. 3). Once the burner has lit, a temperature sensor detects this, an LED lamp 508 lights to indicate gas lit, and the user may release the switch 500 back to the "on" position 504. If the user releases the switch before the gas lights, the gas supply will be switched off, and hairdryer will continue to blow out cold air. The switch must again be moved to the "ignite" position 506 to switch on the gas supply and enable the ignition circuit.

The heat level is controlled by a switch (or manual regulator) 510 giving two heat levels or a number of heat settings.

After use the user moves the slide switch to the "off" position 502. This stops the fan and closes the gas supply valve. To re-ignite gas supply the user must repeat the ignition sequence.

A "cool shot" options is also possible involving extinguishing and re-igniting the burner. Cold air operation is possible by switching the unit to "off", then moving the switch to "on" without igniting the gas.

As regards ignition of the burner, a preferred implementation is the electronic spark ignition system 430 discussed above that repeatedly produces a spark until the gas has been lit or the user releases the ignition button. Such an electronic system can be used in a similar fashion to a conventional mains powered dryer.

The cheaper alternative is a simple mechanical piezo-ignition system of any appropriate type. The piezo would be triggered once when the user moves the on/off/ignite switch 500 into the ignition position. The disadvantage is that the user will need to repeat the process if the burners fail to light, and this might not be apparent for several tens of seconds if the burners are not visible.

Further safety and related aspects include the placement of the spark electrodes, chosen to further minimise the risk of ignition of gas products due to the build up of silicone on the spark electrodes.

Also, to prevent hair ingress into the product a filter or grill is placed at the air inlet. This prevents hair being drawn in and becoming entangled with the fan and keeps other debris out.

Furthermore, to prevent debris drawn into the hairdryer (eg. fluff, hair, etc.) from being ignited by the gas burners and ejected as burning or very hot particles, firstly the air inlet filter will prevent most particles from being drawn into the hairdryer, and secondly, the risk of any particles that are drawn in, coming into contact with a flame or a very hot surface is minimised by the product design,. In particular, the gas burners are catalytic and therefore burn without a substantial flame at temperatures of approximately 500-800C (rather than 1300C). Furthermore, these hot catalytic surfaces are protected from the intake air to maintain combustion. Thus particles drawn through the product are not exposed to high temperatures capable of posing a hazard.

Yet further, products that might reasonably be used with the hair dryer such as gels and hairsprays do not present a safety risk as a result of various features.

For example, airflow is controlled through the product so that aerosols etc are less likely to come into contact with surfaces that are sufficiently hot to ignite thenm, the spark ignition source is appropriately placed, the operating temperature of the catalytic burners is reduced, and combustion occurs in a safe fashion with the hairdryer.

The invention as described herein is hence simple to use and similar in use to existing corded dryers. It provides gas shutdown in the case of failure of the burners to ignite, or extinguishing for any reason, two (or more) levels of heat output and fan speeds, gas ignition, reduced airflow detection and gas shutdown, over-temperature detection and gas shutdown, under-temperature

detection and gas shutdown (which may be used to detect ignition failure), battery low indicator and burner on indicator.

It will be appreciated that features and components from the various embodiments can be combined or interchanged as appropriate without departing from the inventive concept. The individual components described, to the extent they are generic or off-the-shelf products, will be well known to the skilled reader and hence have not been described in detail.

Claims

1. A hairdryer comprising:

a housing defining an air passage;

a battery adapted to power a motor and a fan driven by the motor to drive air down the air passage;

a burner in the air passage and in the form of a sleeve enclosing at its open end a catalyst;

a combustible gas supply flow to the burner;

wherein a first baffle shrouds the burner and prevents air that flows in the passage around the baffle and burner from cooling the burner; and

a second baffle deflects combusted gas exiting the burner so as to mix with air after flowing around the burner.

2. A hairdryer as claimed in claim 1, in which the sleeve is finned behind the burner to shed heat, conducted from the burner, through radiation and convection to the surrounding airflow.

3. A hairdryer as claimed in claim 2, in which said first baffle extend from one of said fins.

4. A hairdryer as claimed in claim 3, in which said first baffle extends from the fin of the sleeve which is closest to the burner.

5. A hairdryer as claimed in any preceding claim, in which the burner includes a catalyst in the form of a coil of platinum coated wire.

6. A hairdryer as claimed in any preceding claim, in which the second baffle comprises a ceramic block that leaves an annular space in the air passage through which the combusted gas and air flow.

7. A hairdryer as claimed in claim 6, in which the second baffle is truncated at its rear end in the direction of air and combusted gas flow to create turbulence in the flow to ensure complete mixing of the air and combusted gas.

8. A hairdryer as claimed in claim 7, in which the baffle is coned in the direction of flow.

9. A hairdryer as claimed in any preceding claim, in which a third baffle is disposed upstream of the burner and creates a tubular flow of the air driven by the fan.

10. A hairdryer as claimed in claim 9, in which said third baffle comprises the motor being arranged in the air passage downstream of the fan.

11. A hairdryer as claimed in claim 9 or 10, in which the third baffle comprises a cupped plate.

12. A hairdryer as claimed in any preceding claim, in which the burner comprises a port in the sleeve downstream of said first baffle and through which air is drawn by, and to mix with, gas supplied through the sleeve and so as to create said combustible gas.

13. A hairdryer as claimed in claims 11 and 12, in which said third baffle shrouds the port and creates a positive pressure at its entrance.

14. A hairdryer as claimed in any preceding claim, in which, the fan is a radial fan drawing air axially through an end opening of the housing and expelling the air radially from the fan against shrouds that deflect the air into a tubular flow.

15. A hairdryer as claimed in claim 13, in which said shrouding comprises the housing itself.

16. A hairdryer as claimed in any preceding claim, in which there are a plurality of said burners in the air passage, arranged with their longitudinal axes parallel.

17. A hairdryer as claimed in claim 15, in which there are two of said burners in the air passage, the second baffle comprising a ridge parallel a line joining said longitudinal axes, and a hip at each end substantially on the longitudinal axis of the respective burner.

18. A hairdryer comprising a burner, a fuel reservoir storing fuel and an electromechanical control for controlling fuel supply from the reservoir.

19. A hairdryer as claimed in claim 18 in which the control includes at least one of a reservoir valve and an electronic valve control circuit.

20. A hairdryer as claimed in claim 19 in which the reservoir valve is set to close on failure of the control circuit.

21. A hairdryer as claimed in claim 20 in which the reservoir valve comprises a biased closed solenoid valve.

22. A hairdryer as claimed in any of claims 19 to 21 in which the control circuit includes a valve control element that is electrically isolated from the control circuit.

23. A hairdryer as claimed in claim 22 in which the valve control element is opto-isolated from the control circuit.

24. A hairdryer as claimed in any of claims 18 to 23 in which the control circuit includes a condition sensor.

25. A hairdryer as claimed in claim 24 in which the condition sensor comprises at least one of an under-temperature or over-temperature sensor.

26. A hairdryer comprising a burner, a flow passage and at least one baffle diverting flow in the passage in which a condition sensor is provided in conjunction with the baffle.

27. A hairdryer as claimed in claim 26 in which the condition sensor comprises at least one of a under-temperature or an over-temperature sensor.

28. A hairdryer as claimed in claim 26 or 27 in which the baffle shrouds the burner.

29. A hairdryer including as components a gas burner, a gas reservoir, a fan and a battery for powering the fan in which the components are configured to avoid obstruction of the airflow from the fan to the burner.

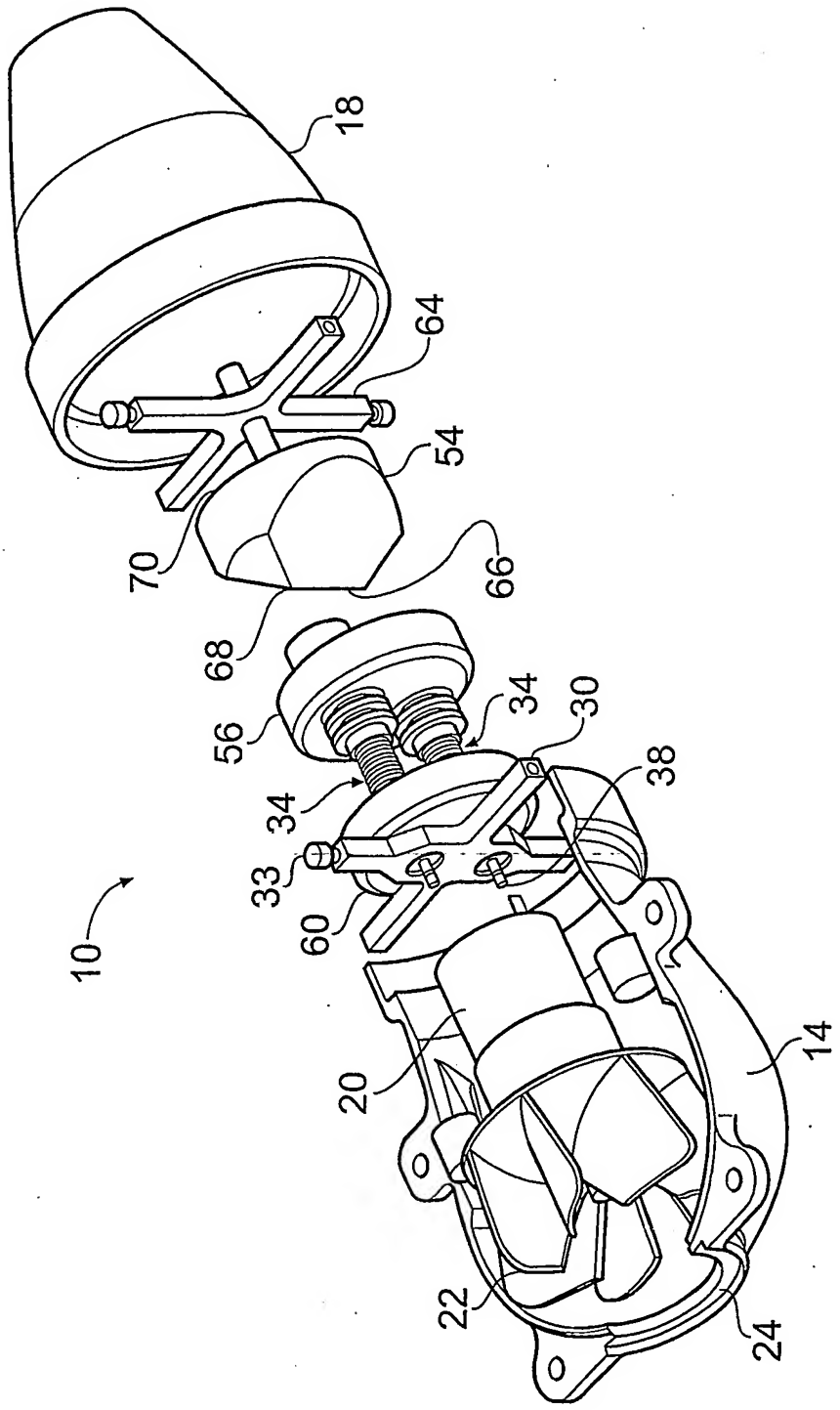

Fig. 1

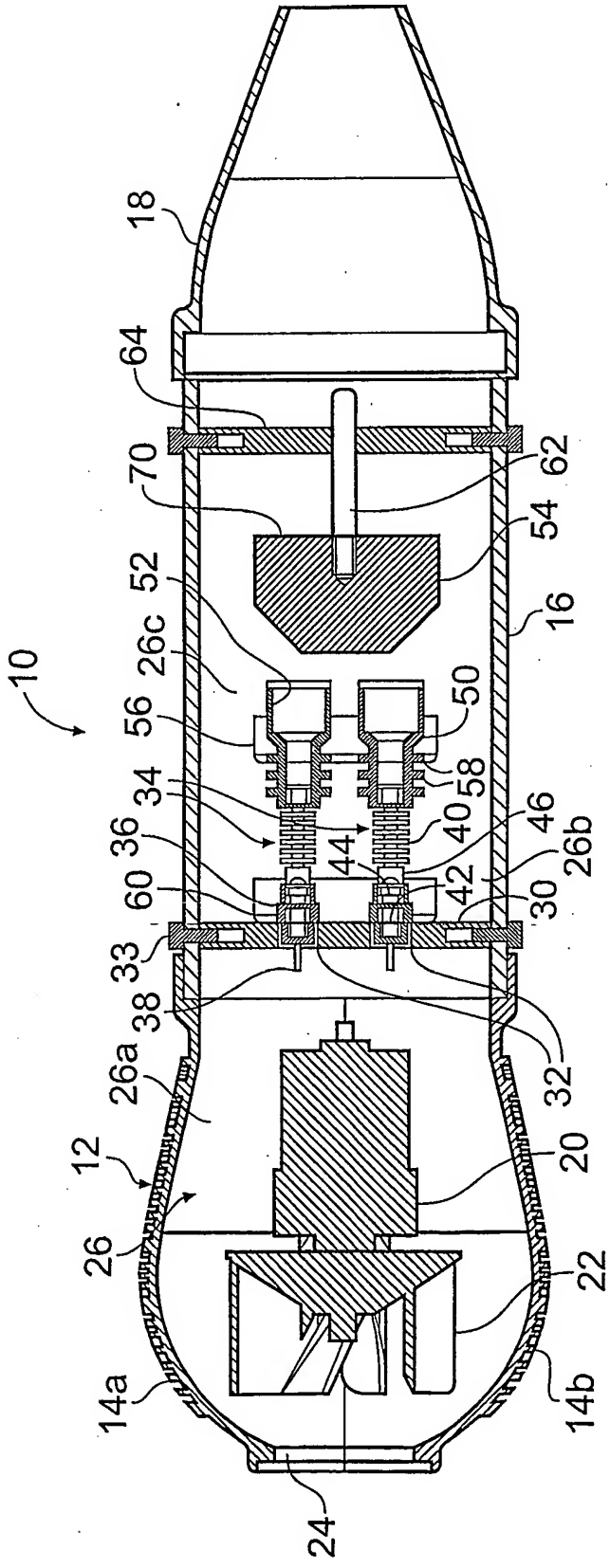
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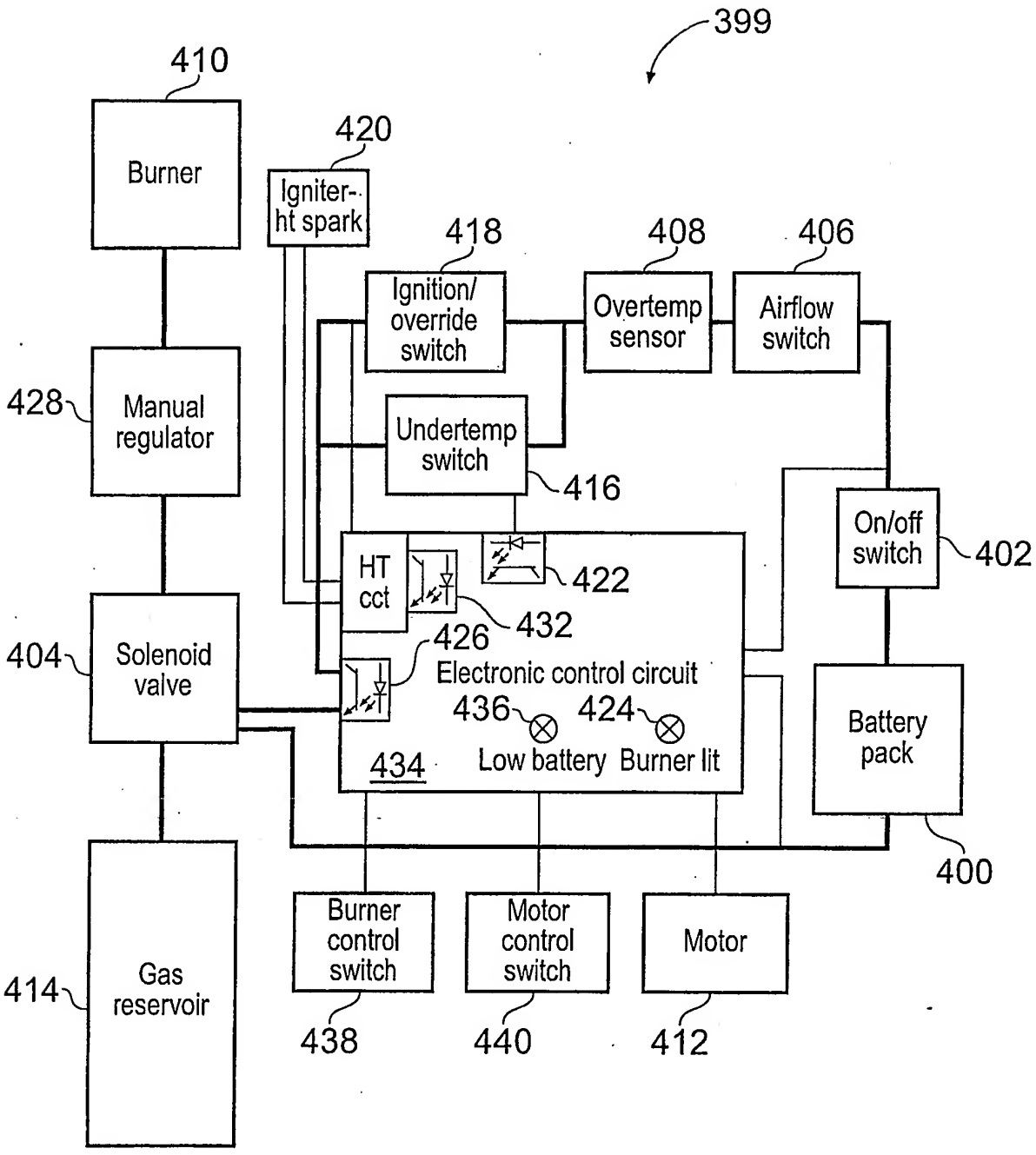
Fig. 2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410
Burner
420
Igniter-ht spark
418
Ignition/ override switch
408
Overtemp sensor
406
Airflow switch
428
Manual regulator
Undertemp switch
416
On/off switch
402
HT cct
422
432
426
404
Solenoid valve
Electronic control circuit
436
424
Battery pack
434
Low battery
Burner lit
400
Burner control switch
Motor control switch
Motor
414
Gas reservoir
438
440
412

Fig. 3

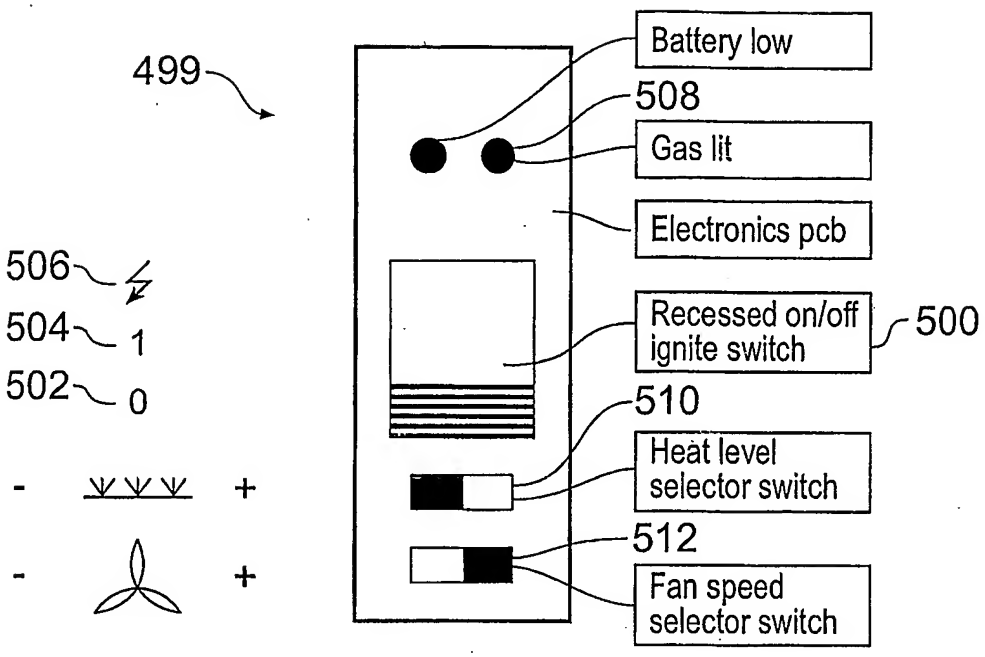
499
Battery low
508
Gas lit
Electronics pcb
506
504
1
502
0
Recessed on/off ignite switch
500
510
Heat level selector switch
512
Fan speed selector switch
-
+
-
+

Fig. 4

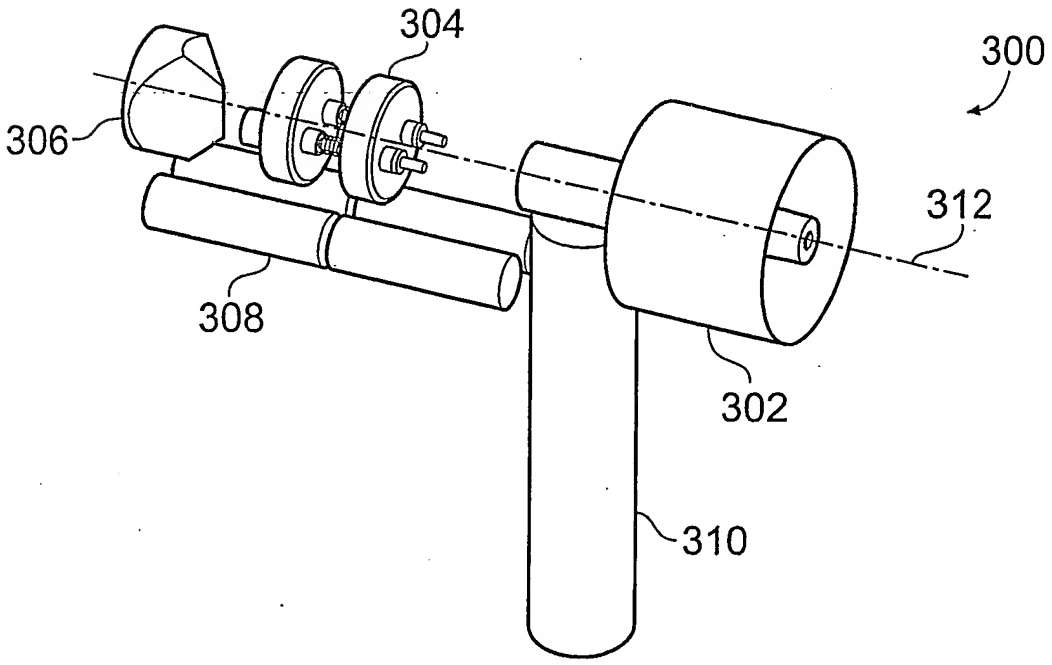
304
300
306
312
308
302
310

Fig. 5

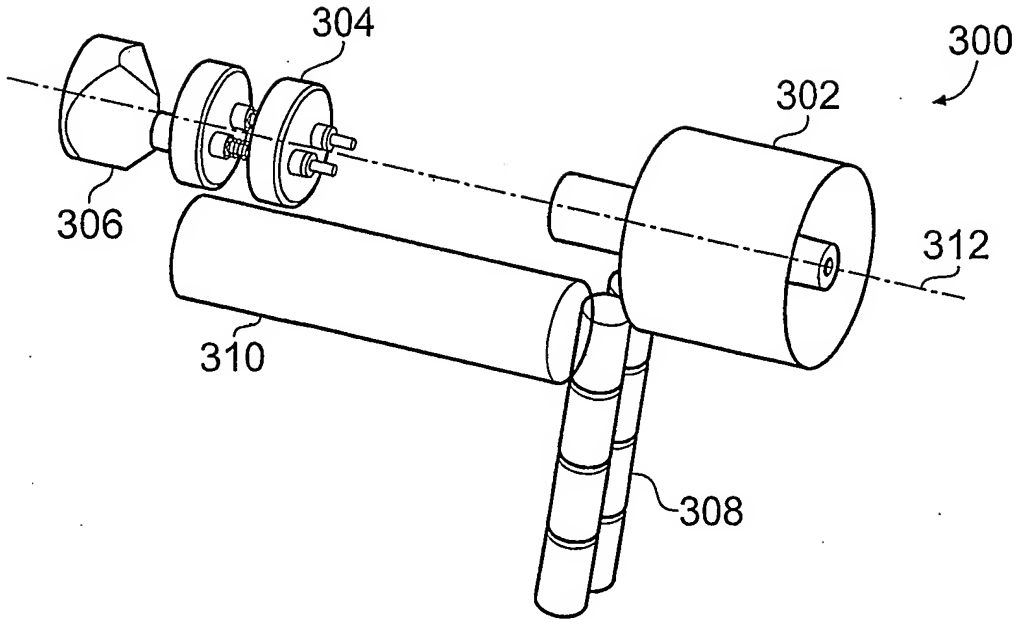

Fig. 6

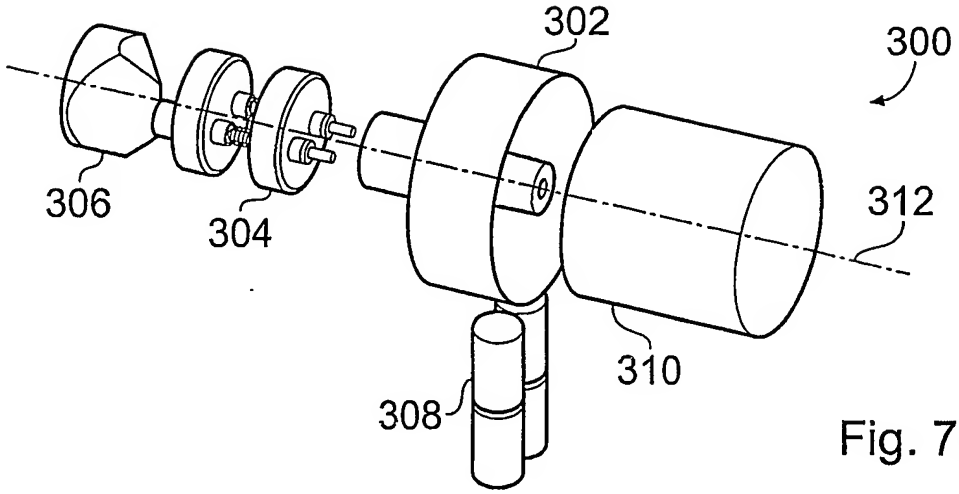

Fig. 7a

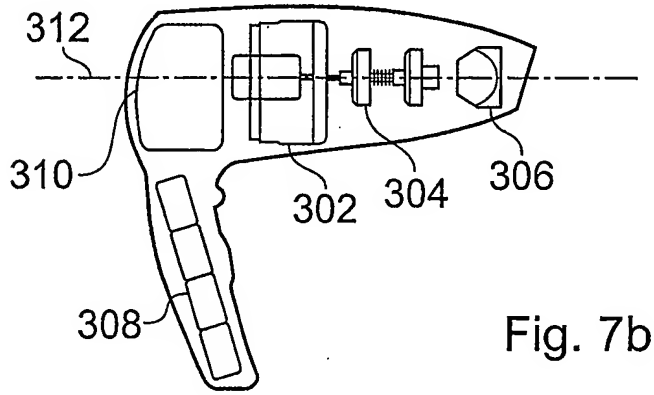

Fig. 7b

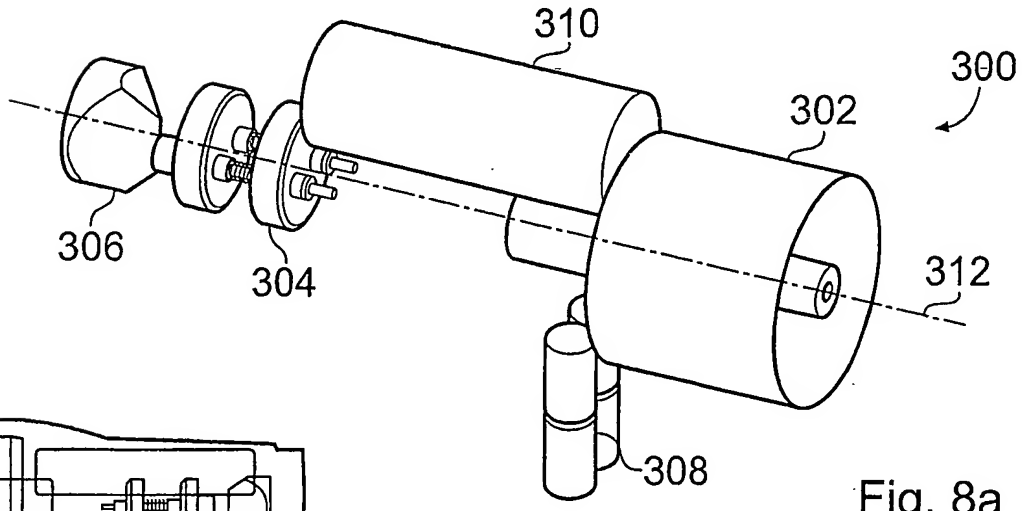

Fig. 8a

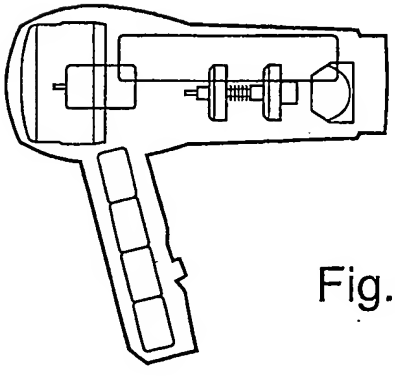

Fig. 8b

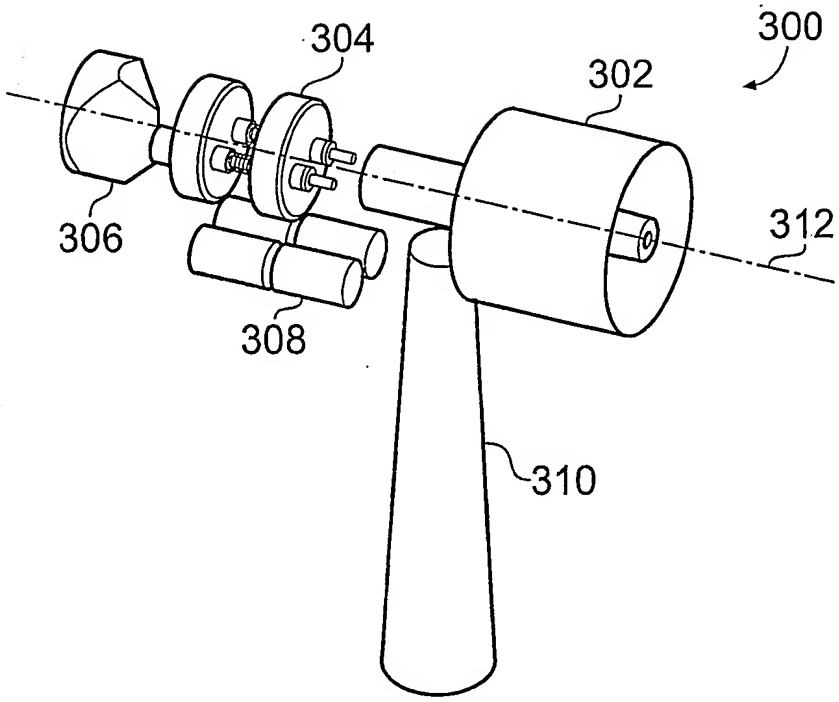

Fig. 9a

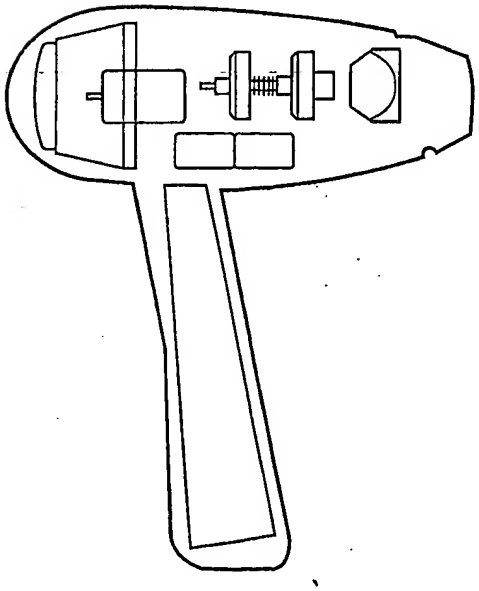

Fig. 9b

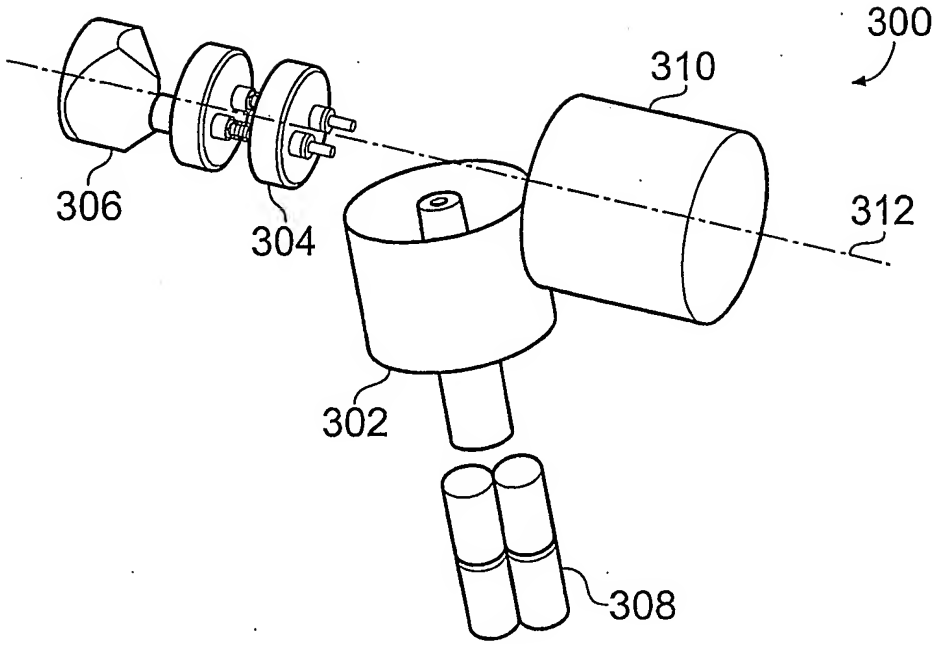

Fig. 10a

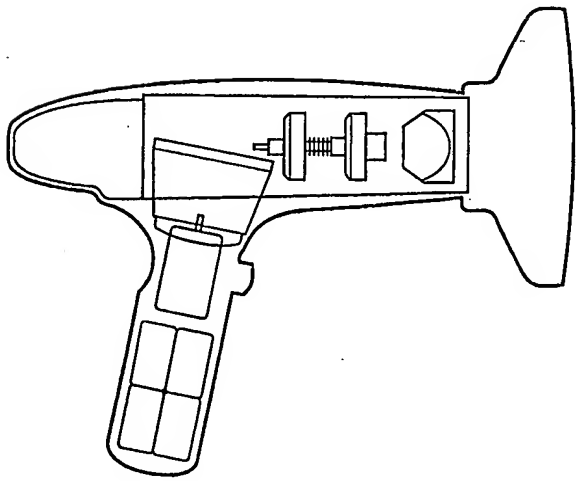

Fig. 10b

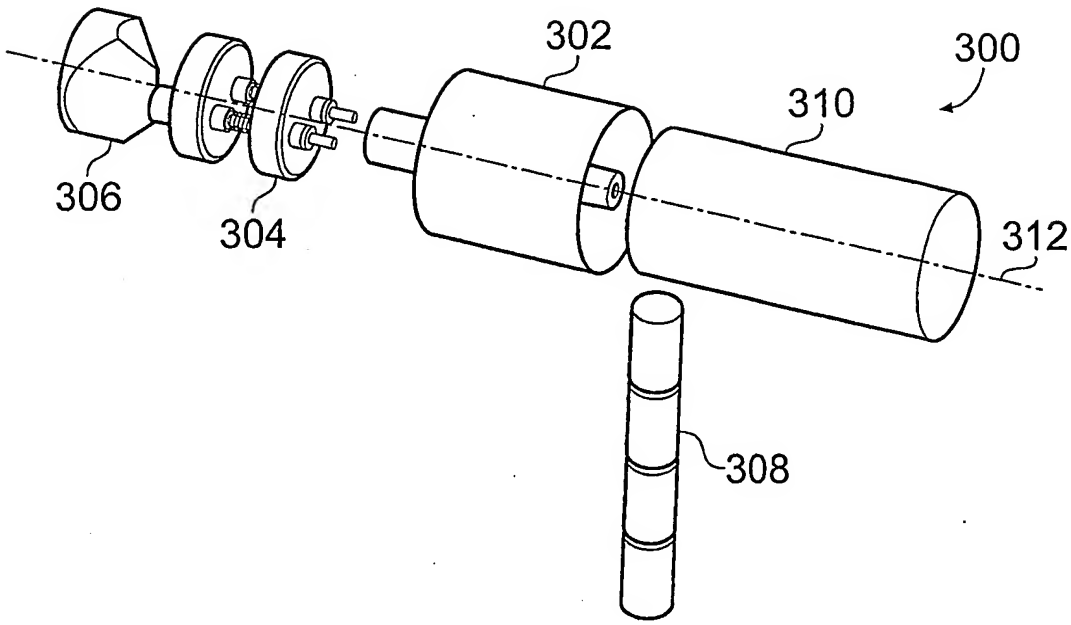

Fig. 11a

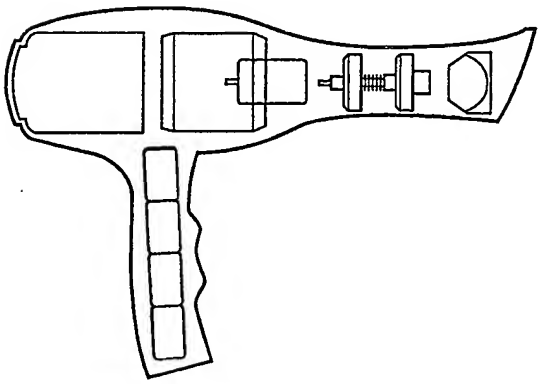

Fig. 11b

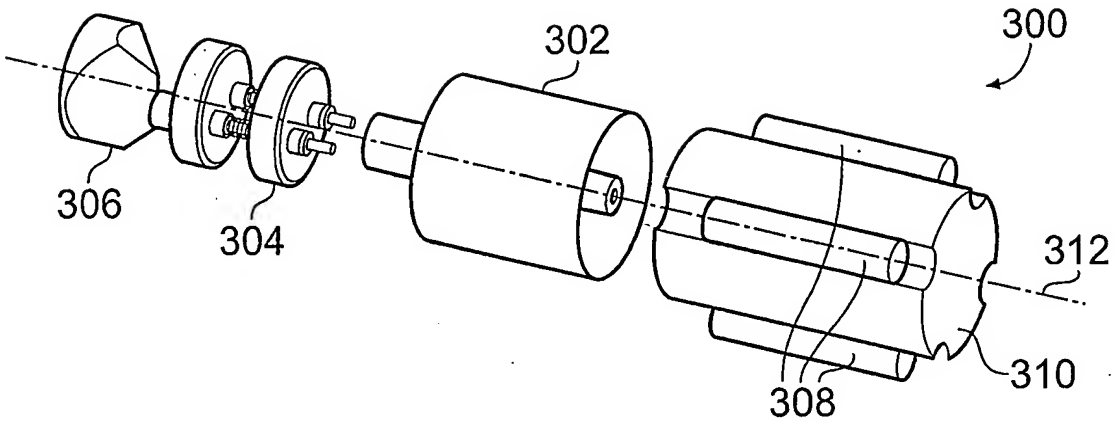

Fig. 12a

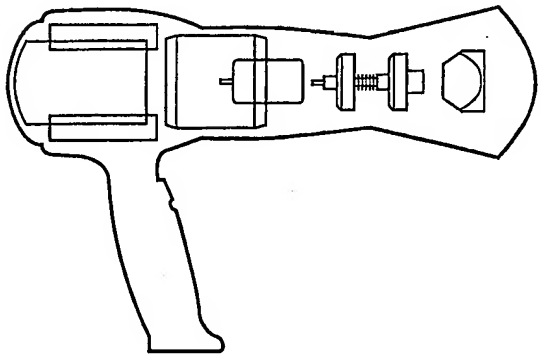

Fig. 12b